Midwest Ozone Group mog

February 14, 2000

(VIA UPS and Fax - (215) 814-2124)
David L. Arnold, Chief
Ozone & Mobile Sources Branch, Mailcode 3AP21
U.S. Environmental Protection Agency, Region 3
1650 Arch Street
Philadelphia, PA 19103

Re: EPA's Proposed Rule Entitled "Approval and Promulgation of Air Quality Implementation Plans; Pennsylvania; 1-Hour Ozone Attainment Demonstration for the Philadelphia - Wilmington - Trenton Ozone Nonattainment Area"
64 Fed. Reg. 70428 (Dec. 16, 1999)

Dear Mr. Arnold:

These comments are offered on behalf of the Midwest Ozone Group ("MOG")[1] in response to the proposed rule published in the December 16, 1999 Federal Register concerning the 1-hour ozone attainment demonstration for the Pennsylvania portion of the Philadelphia - Wilmington - Trenton Ozone Nonattainment Area (64 Fed. Reg. 70428). In the December 16, 1999 proposal, EPA announced its intent to approve or conditionally approve, or in the alternative, disapprove the 1-hour ozone attainment demonstration for the Pennsylvania portion of the Philadelphia - Wilmington - Trenton Ozone Nonattainment Area.

MOG is pleased to have the opportunity to offer comments regarding this proposal. As an integral part of the development of these comments, MOG retained the services of Alpine Geophysics, LLC. A complete copy of the report of Alpine Geophysics is enclosed and incorporated into these comments.

Principal among our concerns related to this proposal are the following:

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[1] MOG is an affiliation of over 20 companies, trade organizations, and associations which have drawn upon their collective resources to advance the objective of seeking solutions to the development of legally and technically sound ambient air quality regulatory programs. It is the primary goal of MOG to work with policy makers in evaluating air quality policies by encouraging the appropriate application of science and law.
{C0360826.1}

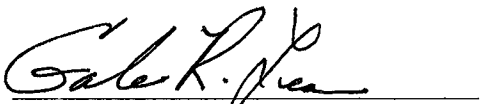
1. There is no basis for the conclusion reached by EPA in its proposal that state attainment demonstrations should assume implementation of the NOx SIP Call. As discussed by Alpine Geophysics, modeling data demonstrate that the benefits of imposing the NOx SIP Call controls is limited to the application of those controls to sources located in or nearby the nonattainment areas in question. There is simply no basis for the application of NOx SIP Call controls to a broad geographic area.

2. EPA's methodology for carrying out its weight of evidence demonstration assume that the relationship between ozone and its NOx and VOC precursors is linear and can be estimated. There is, of course, no basis for this assumption. It is well-established that these functions are not linear.

3. The errors associated with the Regional Ozone Transport Reduction ("ROTR"), Supplemental Notice of Proposed Rulemaking ("SNPR"), and Tier II SNPR emissions inventories, particularly for point sources and for sources located in Canada, should be quality assured and corrected before any additional modeling is performed or the use of existing regional modeling is made.

For the foregoing reasons, MOG urges EPA to withhold making a final determination until such time as EPA corrects these technical and scientific errors, or in the alternative, to disapprove the 1-hour ozone attainment demonstration for the Pennsylvania portion of the Philadelphia - Wilmington - Trenton Ozone Nonattainment Area.

Respectfully submitted this 14th day of February, 2000.



David M. Flannery
Tel: (304) 340-1017
E-mail: dmflannery@jacksonkelly.com
Gale R. Lea
Tel: (304) 340-1200
E-mail: galelea@jacksonkelly.com
Counsel for the Midwest Ozone Group
Jackson & Kelly PLLC
1600 Laidley Tower
P. O. Box 553
Charleston, WV 25322

Final Report

APPRAISAL OF TECHNICAL SUPPORT DOCUMENTS UNDERPINNING EPA'S PROPOSED RULEMAKING CONCERNING 1-HR OZONE ATTAINMENT DEMONSTRATIONS IN THE EASTERN U.S.

AG-90/TS155

Prepared for:

Midwest Ozone Group
c/o Jackson and Kelly, PLLC
1600 Laidley Tower
Charleston, West Virginia 25322

Prepared by

T. W. Tesche
Alpine Geophysics, LLC
3479 Reeves Drive
Ft. Wright, KY 41017

9 February 2000

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1.0 INTRODUCTION

On behalf of the Midwest Ozone Group (MOG), Alpine Geophysics, LLC (AG) reviewed the recent Technical Support Documents (TSD's) developed by the U.S. Environmental Protection Agency (EPA) to justify its 16 December 1999 proposed rulemaking concerning 1-hr ozone attainment demonstrations by various states in the Eastern U.S.

In the TSDs for each area EPA sets forth additional volatile organic compound (VOC) and nitrogen oxides (NOx) emissions controls beyond those identified in the 1-hr ozone attainment demonstration plans that the agency asserts are needed to ensure that the federal ozone standard will be met. Using the urban-scale photochemical modeling analyses submitted by the states together with results of EPA's Regional Ozone Transport Reduction (ROTR) modeling (i.e., the Regional NOx SIP Call), EPA employs a "relative weight-of-evidence" analysis that attempts to build upon existing photochemical grid modeling to estimate the effects of unmodeled emissions reduction scenarios on peak 1-hr ozone levels in severe and serious nonattainment areas. These new emissions control scenarios include the agency's Tier II/Sulfur proposal and "additional emissions reductions" that the EPA asserts in the TSDs as needed to ensure 1-hr attainment. The methodology for developing these additional emissions control requirements is presented in (EPA, 1999).

In this report, we assess several technical issues arising from our review of EPA's TSD'S, the "relative impacts weight-of-evidence" methodology (EPA, 1999), and associated technical information. In particular, the TSDs were examined with the following three technical issues in mind:

> Is there an adequate scientific basis for the methodologies used in and conclusions drawn by the EPA in the agency's "Additional Emissions Reductions" methodology? Have these methodologies been scientifically peer-reviewed?

> Is the ROTR regional modeling used by EPA to assess stipulated VOC and NOx controls in the eastern U.S. and Canada valid technically? Are the results obtained with the year 2007 modeling scenarios reliable and does the modeling provide a credible basis for defining additional ozone controls in the eastern U.S. serious and severe nonattainment areas?

> Have sufficient *local* control measures been identified in the SIPs to ensure that the 1-hr ozone standard will indeed be attained in the serious and severe nonattainment areas in the eastern U.S.?

In Section 2 we discuss the key scientific limitations of EPA's "relative weight-of-evidence' analysis (i.e., the 'shortfall analysis') leading to the agency's additional emissions control requirements. Section 3 contains our summary and recommendations.

2.0 TECHNICAL DEFICIENCIES IN THE EPA SHORTFALL ANALYSIS

2.1 Use of Erroneous Emissions Estimates in the EPA Regional Modeling Analysis

The main underpinning of the EPA's shortfall analysis is the agency's photochemical modeling associated with the Regional Ozone Transport Reduction (ROTR) Supplemental Notice of Proposed Rulemaking (SNPR) and Final SIP Call Budget (EPA, 1998a,b). In these analyses, building upon the OTAG modeling and analysis, EPA constructed emissions inventories for the purpose of estimating the effects of regional-scale VOC and NOx controls on peak 1-hr ozone concentrations in the various nonattainment areas in the eastern U.S. Using base year and future year regional-scale UAM-V modeling runs over the 22 eastern U.S. states, EPA devised a simple linear scheme (EPA, 1998c) for scaling historical measured ozone design values to account for the effects of proposed new regional emissions controls (i.e., the NOx SIP Call). The ROTR modeling data bases were also used by EPA to develop "scaling factors" to account for the effects of local Tier II controls in the serious and severe nonattainment areas and, where "shortfalls" were estimated, to calculate further emissions reduction requirements.

While the OTAG/SIP Call and ROTR databases have been widely used by the EPA for public policy making, this modeling framework has also been widely criticized in the scientific community. Specific criticisms of the OTAG/SIP Call/ROTR modeling frameworks derive principally from (a) the technical shortcuts that were taken in the OTAG/SIP Call process to develop the input databases. (b) the "rush to application" of the models (Tesche, 1996; Tesche et al., 1998a,b) before the data sets were adequately quality-assured and the models thoroughly evaluated, and (c) the continued lack of adequate attention to correcting flaws in the modeling data bases, particularly the emissions.

Adequate quality assurance activities and error correction steps have still not been carried out by the EPA despite the fact that these deficiencies have been known for quite some time.

Unfortunately, the ROTR modeling data bases EPA has used to support recent guidance and policy documents (e.g., EPA, 1998b,c; 1999b,c) contains important flaws that raise questions as to the basic validity of the conclusions drawn from the agency's work. Two of the most concerning errors in the EPA regional modeling are as follows.

2.1.1 Point Source Emissions In the EPA Modeling are Incorrect

The EMS-95 emissions modeling system (Wilkinson et al., 1995; Alpine Geophysics, 1995) was used by EPA in the OTAG, SIP Call, and ROTR processes to construct UAM-V inputs was based on the 1990 US and Canadian National Emissions Inventories (NEI). During the OTAG/SIP Call process several attempts were made to correct gross problems in the 1990 NEI. However, because there never was a formal Quality Assurance (QA) activity as part of OTAG, and given the extreme schedule constraints of OTAG and the SIP Call process, many errors in the modeling inventory were either not identified or not corrected in the modeling. Many simplifying assumptions and/or shortcuts were made in the OTAG emissions development process that did not receive full public consideration and documentation due to OTAG's schedule pressures. Important decisions went unnoticed and/or untested. The reports by Tesche et al.,

(1998ab) describe many of the problems in the 1990 and year 2007 emissions in the U.S.

Many of these errors were carried over uncorrected into the EPA SIP Call and ROTR modeling. While a number of the inventory problems initially identified in the OTAG process were addressed, many remain uncorrected.

For example, in the past year, AG has found *significant* errors in the SIP Call/ROTR point source emissions data. In particular, the point source foundation files remain significantly in error due to miscalculation of stack emissions flow rates. This erroneous treatment of point source stack parameters is due to a data processing error in the raw OTAG emissions foundation database used to calculate flow rates from individual point sources. The effect of these errors is to give erroneous flow rates, some hypersonic (i.e., more than 1.5 times the speed of sound) and plume rise values to the NOx emissions from point sources, placing emissions from many stacks either out of the modeling region (through the top boundary) or placing the emissions in a grid level above the mixed layer and close to the top boundary of the model. This effectively removes many sources from the photochemical model calculations near the ground because they are advected out of the region before they can mix down. Since the SIP Call and ROTR modeling focuses heavily upon the control of NOx emissions from point sources, any systematic error in modeling these emissions calls into question the validity of the entire modeling study.

Our investigations (McNally and Tesche, 1999; Tesche and McNally, 1999) demonstrated that these errors affect not only the EPA NOx SIP Call and ROTR modeling and the modeling performed by EPA in support of the Tier II/Sulfur rulemaking, but in SIP modeling performed in the upper Midwest states (e.g., the Chicago-Gary-Milwaukee region) over the so-called Grid-M region.

To demonstrate the impact of these stack parameter errors on the SIP Call and ROTR base case and future year modeling runs, we performed calculations over both the Grid M region (i.e., the Midwest and portions of Ontario and Quebec) (Tesche and McNally, 1999) as well as the full OTAG domain (McNally and Tesche, 1999). In these analyses, the point source stack parameter files were corrected and four (4) year 2007 base case emissions control simulations were performed. In the Lower Lake Michigan Region, *with the stack parameters corrected:*

> Daily maximum predicted ozone concentrations increased in the June 1995 episode by 10 to 20 ppb or more; for the July 1995 episode, the daily maximum predicted ozone concentrations decreased by 10 to 20 ppb or more, depending upon the day;

> The mean bias in the July 1995 episode was increased from 0.9% to 10.7%; and

> The mean gross errors were degraded (from 25% to 31.2%) for the June episode and essentially unchanged for the July episode.

More importantly from a regulatory standpoint, there were significant day-to-day discrepancies in the daily maximum ozone concentrations predicted by the model when the uncorrected EPA ROTR point source emissions inventories were used. The magnitude of the local ozone

prediction errors ranged from location to location and from day to day during the modeling episodes. While typically the ozone prediction errors were in the range of 2 to 6 ppb, in some areas the ozone errors were as high as ± 30 ppb *or more*. The findings of the Grid M and full OTAG domain simulations with the erroneous EPA ROTR emissions inventories demonstrates that the ozone modeling scenarios used by the EPA to develop "rollback" factors for design value modification (EPA, 1998c) and to estimate 'shortfalls' in ozone attainment plans (EPA, 1999a) are simply invalid. These emissions inventory errors need to be corrected before any control scenarios can be credibly analyzed with the EPA SIP Call/ROTR databases.

2.1.2 Canadian Emissions In the EPA Modeling Have Important Shortcomings

The Canadian emissions inventory included in the SIP Call/ROTR modeling database was hastily developed during the OTAG process and never underwent meaningful quality assurance or peer-review. This is of concern because of the proximity of significant Canadian sources to certain of the northeastern U.S. nonattainment areas and the potential impact that these areas have under westerly to northwesterly wind regimes. Given the number of problems uncovered in the review of just the U.S. portion of the OTAG/SIP call inventories, significant concern exists over the adequacy and reliability of the Canadian emissions database used in the EPA SIP Call/ROTR modeling.

There are several problems or troubling features associated with the development, archiving and/or reporting of the emissions developed for the Canadian portion of the 36/12 km OTAG domain. The major ones include:

> Canadian emissions for the base year (1990) were not adjusted for the actual conditions of the July 1998 and July 1995 episodes. Examination of the 2007 Canadian emissions modeling data bases in the EPA ROTR data base reveals that for the SIP Call modeling, no growth and control factors were used to project the 1990 baseline Canadian emissions to the year 2007;

> The only spatial surrogate used for distributing area source emissions in the Canadian provinces was population. Thus all area source and motor vehicle source are based on the Canadian population distribution. This is a very great oversimplification and one that improperly distributes ground-level emissions throughout the Canadian provinces;

> In the SIP CALL/ROTR modeling, Canadian motor vehicle and area source emissions were apparently included in the air quality model-ready data files, but the "raw data" input data sets available from the EPA do not include Canadian emissions. Thus, it is unclear just where or how (or if) the Canadian emissions were created. They were apparently patched in at some point in the data processing stream, but there is no record of this. It is therefore impossible for the Canadian emissions to be independently examined and quality-assured.

> No particular attention was been given to quality-assuring the Canadian portion of the SIP Call/ROTR emissions inventory. It has certainly not been subjected to

nearly the same level of scrutiny as the U.S portion. Given many problems found in the U.S. inventory (some still exist), there is justifiable concern that the Canadian emissions used in the EPA SIP Call/ROTR modeling have significant remaining problems,

2.2 Linearity Assumption not Substantiated

EPA (1999a) presents draft guidance for estimating the additional levels of emissions reductions needed to support the 1-hr NAAQS for ozone in nonattainment areas beyond the reductions from control measures proposed in the state's SIP submittals. This approach uses a "weight-of-evidence" approach to demonstrate attainment.

Two methods are given by EPA for carrying out the weight of evidence. Both methods assume that the relationship between ozone and its NOx and VOC precursors is *linear* and can be estimated. Method 1 uses the change in modeled ozone to the change in the modeled precursor emissions to establish the relationship between ozone and precursors. Method 2 uses the change in the monitored air quality (i.e., design values) to the change in the reported emissions inventory between the base year (say, 1990) and a subsequent periodic emissions inventory (e.g., the 1996 National Emissions Trends inventory). EPA (1999a) considers both methods equally valid although the utility of either method depends on the availability of data which support the linearity assumption. EPA has not demonstrated that either method is technically valid.

2.3 Inconsistent Use of Weight of Evidence Methodologies

EPA (1996) provides guidance on the use of "weight-of-evidence" analyses to support modeling attainment demonstrations. This guidance identifies two specific methods (i.e., the deterministic and statistical approaches) for assessing whether the modeling has provided convincing evidence for the likelihood of attainment. However, EPA asserts that the 1996 guidance and recommended weight-of-evidence methods are not to be used to determine the levels of controls (i.,e the emissions reduction targets) needed for attainment. However, the recent EPA guidance (EPA, 1999a) contradicts this posture by advancing a weight of evidence methodology that can be used in a relative sense to determine the controls needed for the states. Apparently, the states cannot use weight of evidence analyses for attainment calculations, but EPA can.

2.4 Source Regions Most Heavily Influencing Ozone Concentrations In the Northeast U.S. are Not Adequately Targeted

2.4.1 Recent Rollout Modeling Results Not Considered

A number of refined and focused modeling analyses have been carried out in the past 3 years to identify which source regions are most influential in contributing to the 1-hr and 8-hr ozone exceedances in the eastern U.S.(Tesche et al., 1998b). One powerful technique, developed originally by the OTAG Modeling Centers is "rollout modeling". Although not used extensively during OTAG due to time constraints, 'rollout modeling' analyses by the OTAG modeling centers and others have raised serious questions as to the validity and effectiveness of a uniform

22-state wide approach to regional emissions reductions.

During OTAG, the Midwest and Northeast OTAG Modeling Centers and researchers at Tennessee Valley Authority (TVA) independently carried out a number of UAM-V modeling and analysis activities using the so-called rollout modeling approach. Many of the results were presented in public meetings during the OTAG process. Imhoff and Gautney (1998) describe two unique applications of the UAM-V photochemical model at TVA using primarily the July 1995 OTAG episode:

> **Rollout Modeling:** The rollout modeling assessment requires a number of UAM-V runs. In the rollout methodology, a particular control strategy of interest (e.g., the OTAG 5c controls) is first applied to the problem area itself, say the Northeast Corridor. Subsequently, controls are applied in successive UAM-V runs in which the geographical region over which the controls are imposed is increased in size in a stepwise fashion, either in circles of expanding radii or in tiers of grid cells added onto the original problem area. The effects of controls in each of the larger areas are compared back to the effects of controls on the original problem area. Applied in this manner, the rollout methodology allows one to determine quantitatively the distance beyond which additional controls cease being effective in improving ozone in the original problem area.

> **Reactive Tracer Modeling:** The reactive tracer UAM-V simulations were aimed at examining the rate at which ozone is removed from the atmosphere. Anthropogenic NOx and VOC emissions and biogenic NOx emissions are turned off 48 hours and 24 hours before a time of interest in the model simulation. The biogenic VOCs emissions are retained in the model simulation to give the NOx remaining in the system an opportunity to form ozone and to preserve one of the important ozone removal mechanisms. The concentrations in this run are then compared with the base case to estimate the amount of ozone formed due. to emissions in the previous 24 hours. In other words, the results allow one to estimate the decay rate of ozone in the atmosphere due to natural removal, dilution, and conversion processes.

Among the pertinent TVA findings reported by Imhoff and Gautney (1998) are:

> Both the rollout and reactive tracer modeling indicate that meaningful ozone reductions at high concentration locations (e.g., the Northeast Corridor) are difficult to achieve by controlling sources far away from the problem areas;

> Different regions of the eastern U.S. have very different characteristic scales of ozone transport with Atlanta having the shortest and Lake Michigan the longest;

> Defining the Area of Influence (AOI) as the distance at which 75% of the overall effects of the domain-wide OTAG 5C controls are achieved. TVA found for that for base-case (i.e., no controls beyond those called for in the Clean Air

Act) ozone concentrations above 120 ppb:

- For Atlanta, the AOI is limited to the Atlanta region (AOI-0);
- Controls must extend an additional 192 km beyond the Lower Lake Michigan region in order to achieve 75% of the benefit of domain-wide controls (AOI-192);
- For the Northeast, the AOI is limited to the Northeast region (AOI=0).

> By the time controls have been extended beyond 96 km from the Northeast Corridor, their efficiency is less than one-half that of controls within the corridor itself, and

> Simulated ozone concentrations do not depend significantly on the amount of ozone that has been resident in the model for more than 48 hours, but is strongly dependent on the anthropogenic emissions that have occurred within the preceding 48 hours. These UAM-V findings refute the popular conceptual notion of a cause and effect relationship between transport of localized high ozone from far upwind and nonattainment in the NE.

The TVA analysis demonstrated clearly that to mitigate ozone concentrations in the New York region, it would be most effective to control local and nearby upwind sources. Controls on sources far upwind (e.g., the Midwest and southeast U.S.) were found to be inefficient, impractical and unreliable (Imhoff and Gautney, 1998).

2.4.2 More Recent Subregional Modeling Not Considered

In mid-1998 Alpine Geophysics and ENVIRON International Corporation carried out detailed subregional photochemical modeling in the eastern U.S. on behalf of the Midwest Ozone Group. The goal of this study was to identify the source regions whose emissions were most influential in governing 1-hr and 8-hr ozone nonattainment problems in the northeastern corridor (Tesche et al., 1998c). More than a dozen photochemical model control strategy simulations were performed in the eastern U.S. using the July 1991 and July 1995 OTAG/SIP Call data bases to examine the impacts of progressively more stringent VOC and NOx controls on power plants and low-level sources (including mobile sources) in the Northeast U.S. and the Midwest. Particular emphasis was placed on the merits of focusing emissions controls on the inner portion of the Ozone Transport Region (OTR) compared with controls outside the OTR and elsewhere in the 22-state OTAG regional domain. Details of the MOG subregional modeling are discussed by Tcsche et al,, 1998c and are available on the MOG website (www.midwestozonegroup.com).

Among the key findings were:

> Addition of 30% VOC and NOx controls on motor vehicles and other low elevation sources in the inner zone of the OTR reduces ozone by 14 ppb or more throughout a large region of the inner OTR corridor. The maximum ozone benefits due to these additional controls nearly doubles. This finding occurs for

both the July 1991 and July 1995 OTAG episodes. Moreover, additional controls on motor vehicle emissions in the inner OTR has a significant effect on further lowering the peak and area-wide ozone levels for both episodes and does not lead to significantly increased ozone disbenefits; and

> Imposition of additional controls on Midwestern electric utility sources appears to have a very small impact on daily maximum ozone levels (both peak values and spatial distributions) in the OTR. The magnitude and spatial extent of the ozone impacts from Midwestern sources are not appreciably changed from day to day in the OTR region.

> 55% and 65% NOx controls on Midwestern electric utility sources produces widespread ozone reductions across the Midwest, generally in the range of 2-6 ppb. However, in a number of locations such as Chicago, St. Louis, Louisville, Cincinnati, Detroit, and Pittsburgh, ozone *increases* (i.e., disbenefits) on the order of 6 to 14 ppb or more are predicted during the high ozone afternoon periods.

> The expected impact of significant NOx reductions from Midwestern electric utility sources tend not to produce significant ozone reductions at the same time or location in the Northeast where the peak ozone concentrations (i.e., those affecting attainment) are modeled or measured and they produce far greater increases in peak ozone concentrations in local Midwestern attainment and nonattainment areas than decreases in ozone levels in the Northeast corridor.

Thus, like the Northeast Modeling Center/TVA rollout modeling analyses presented above, the MOG photochemical modeling examining the efficacy of controls inside versus outside of the OTR corridor again demonstrated that to mitigate peak ozone concentrations in the large eastern nonattainment metropolitan areas, it is more effective to control local and nearby upwind sources than to impose controls on sources far upwind (e.g., the Midwest and southeast U.S.).

3.0 SUMMARY AND RECOMMENDATIONS

3.1 Summary

Alpine Geophysics has reviewed the EPA's TSD reports and the recent 'shortfall' modeling methodology (EPA, 1999a). As discussed in the previous section, there are a number of technical shortcomings of the analysis and modeling data bases used to support it. We conclude that the modeling information and simple weight-of-evidence approach used by EPA are inappropriate, in their current form, for use in such an important and economically significant role. A specific summary of the main deficiencies in the EPA analysis are as follows:

3.2 Recommendations

We offer the following recommendations.

Correct EPA Regional Modeling, Emissions Inventories: The errors in the existing ROTR SNPR and Tier II SNPR emissions inventories, particularly for point sources and for sources located in Canada, should be quality assured and corrected before any additional modeling is performed or use of existing regional modeling is made.

Perform Refined, High-Resolution Rollout Modeling In the Northeast U.S. to Quantify the importance of Local Versus More Distant Emissions Controls on Ozone Levels In the Nonattainment Areas: We suggest that the EPA's extend the rollout modeling efforts originally begun by the Northeast Modeling Center as part of OTAG in order to clarify the role of local versus more distant sources in the northeast nonattainment areas, The approach would consist of first defining a limited number (say 2 to 3) key problems areas to study. These might include for example, the New York-Northern New Jersey-Long Island, the Baltimore, and the Philadelphia-Wilmington-Trenton nonattainment areas. For each study area, using corrected emissions inventories a matrix of up to five (5) rollout photochemical model simulations would be performed to quantify the impacts of local versus more distant sources on ozone impacts in each of these study areas. The modeling analysis could be tailored after the original work of Imhoff and Gautney (I 998) and the OTAG northeast modeling center, but would use the most up-to-date (and corrected) emissions inventories available. The July 1995 and July 1991 OTAG episode could be used as the basis for this analysis. This analysis would help elucidate the extent to which upwind source regions emissions reductions are needed to help aggressive local control programs to meet the I -hr ozone NAAQS in the northeastern nonattainment areas.

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Table 1. Summary of TSD Information

Ozone Nonattainment Area	No.	Modeling Days	Relative Reduction Factor	Base Year Design Value, ppb	Future Year Design Value, ppb	Shortfall, ppb	EPA Method	Emissions Reduction Ratio, %ppb	Tier II/Sulfur Invoked?	Additional Reductions Required, tpd
Baltimore	6	19-20 July '91	0.84	152.0	127.5	3.5	2	NOx = 0.19 VOC = 0.96	Yes	NOx = 0 VOC = 13
Greater Connecticut	1	6-8 July '88 10-11 July '88 17-20 July '91	0.67	173.3	116.0	--	--	-- --	No	-- --
NY-Northern NJ-Long Island	2, 13	6-8 July '88 10-11 July '88 17-20 July '88	0.74	174.0	129.0	5.0	2	NOx = 0.61 VOC = 0.83	Yes	NOx = 85 VOC = 6.64
Philadelphia-Wilmington-Trenton	3, 5, 8, 12	7-8 July '88 19-20 July '91	0.83	153.6	127.9	3.9	2	NOx = 0.60 VOC = 1.2	Yes	NOx = 3.4 VOC = 61.8
Springfield, Mass	7	15 Aug '87 17 Aug '87 22 June '88 8 July '88 11 July '88	0.77	157.5	122.0	--	--	-- --	No	-- --
Wash. DC-MD-VA	4	16 July '91 19 July '91 20 July '91	0.88	136.0	119.6	--	--	-- --	No	-- --
Houston-Galveston	11	29-30 July '93 10-11 Aug '93 1-2 Sept '93 8-11 Sept '93 4-5 Oct '92 24-25 Oct '92	0.798	179.0	143.0	19.0	1, 2	-- --	--	NOx = 118
Illinios-Indiana-Wisconsin	10									